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The Making of the World

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The Making of the World

You have gone out at night sometimes when the world was flooded with light that came from the sky. You have looked at the wonderful Milky Way. At first you have tried to count the bright stars. Then you have said, "If I should count all night I could not make a beginning."

Then you have watched the bright stars and wondered how they were made. You have wondered if people live on these stars as they do on our world. You have noticed the tiny bodies between the bright stars. Many of them were so dim you could scarcely see them. You have observed the bright haze that seemed to fill all the space between the stars. Perhaps you have asked some older person what all this light-giving material is. Perhaps you have met the answer, "I do not know."

It is not at all surprising that men do not know the mystery of the Milky Way when we think how very far away from us all these bright bodies are. To give you a little notion of the distance to the nearest star, let us take an imaginary journey Suppose we start on an airship at New York and cross the Atlantic to London. Suppose this journey could be made in one-tenth of a second by your watch. If you could travel in your airship at that unheard-of speed it would take you twenty years to reach the nearest star. Suppose your airship should cross from New York to London in a day. At that rate

of speed it would take you 17,280,000 years to fly to the nearest star. Now does it seem strange that even wise men have to say to you, "I do not know," when you ask them to explain the heavens?

Men are, however, finding out more and more about the heavens as they get more powerful telescopes. A book printed twenty years ago says, "There are 30,000,000 stars or more." A book printed last year declares, "There are, perhaps, 100,000,000 stars." It says that each of these stars is a sun. Many of them are larger than our sun. Many of them may give light to worlds much larger than our own. If these stars, or suns, were nearer, man might learn more. As it is, most of our knowledge has to be confined to our own solar system. By our own solar system I mean our sun and the worlds that journey around it and receive heat and light from it. Men believe that the heavens contain 10,000,000 such solar systems and that our world, seen from a world that travels around another sun, looks like a little star in the sky, or perhaps cannot be seen at all.

Now since the other solar systems are so far away and so hard to learn about, we shall have to confine ourselves to our own system, pretty largely. We have in Chicago a wonderful electric tower. It is covered with electric lights from top to bottom. Yet it is seen for only a few miles and gives almost no heat. We marvel at this wonderful tower, but how feeble it is! This is the work of men's hands. The stars that send light to us from millions upon millions of miles are the work of God's hand. Man, as yet, has learned only a little about them.

About our own sun and the eight worlds or planets that travel around the sun, we know very much more, because they are so much nearer to us. Let me introduce you to the members of our family. You will see by Figure 1, that first and most important comes the Sun. In order of distance from the Sun are the planets Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune. You will see that the Earth, on which we live, is very small compared to some of her sister planets. In fact, Jupiter is greater than all the other seven planets put together. Jupiter, however, has a diameter only one-tenth as great as that of the sun. All of these eight worlds or planets make journeys around the sun and receive heat and light from the sun. The planets near the sun make but a short journey. Mercury can travel around the sun on its nearly circular path and come back to the starting point in 88 of our days. The Earth, being farther from the sun, must make a much longer journey. As you know, it takes 365 days and about 5¾ hours for our earth to make its journey. Neptune, you see, is very far from the sun. For it to make a journey around the sun requires 165 of our years. Figure 1 is so small that it is very hard to realize how far these

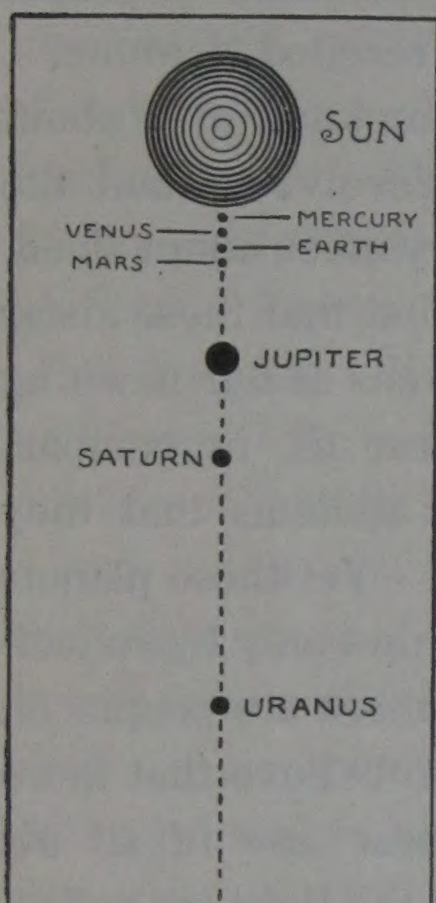


Figure 1

planets are from the sun. To make the matter clear, suppose you were on an express train traveling a mile every minute. If you traveled at that rate from the Sun to the Earth it would take 176 years to reach the Earth, and to reach Neptune 5280 years. If you lived to be eighty years old and your son lived to be eighty and his son eighty, and so on, sixty-six generations of people would live and die before your train reached Neptune.

Is it not very wonderful that men can know even about the seven sisters of our Earth that revolve around the sun with her? Yet they do know very much about them. If you will take an almanac you will find that these sister planets are often shining in the heavens as our morning and evening stars. They are so near us in comparison with the suns of the other solar systems that they appear very splendid in the heavens. Yet these planets are cold bodies like our earth and shine only by reflecting to us the light from the sun. If there are people on the other planets (and it seems fair to believe that there are and that God is making the best use of all his worlds) our earth shines to them by the light we reflect from the sun.

You have sometimes gone outside a room and by the use of a little mirror or bright piece of tin flashed light into the eyes of some one in the house. Your tin was the reflector. The sun was the source of the light. Just so it is when Jupiter reflects the sun's light to us, and though a cold, dark body, appears as a glorious, shining evening star, much brighter than anything else in the heavens. Take your almanac. Find the time at which

Jupiter begins to be our evening star. As it is the largest of our eight planets it will make the most splendid display in the heavens. Men have found out the exact day that this fine planet appears to us and exactly how long it stays visible to us. Do not fail to find Jupiter in the heavens and greet him each night as long as he stays. The sight will repay you for your trouble many-fold. The almanac will tell you, too, when to look for the other planets. Jupiter, however, is as large as all of them combined, and so much nearer to us than Saturn, Uranus and Neptune that they will appear much less glorious. Among the Romans Jupiter was the greatest of all the gods. He was the father of all the gods and goddesses. Do you not think it well to name this glorious planet for him?

Now let us sum up the things men have learned about the eight planets that revolve around our sun. They have learned the distance of each from the sun. They have measured the size of each planet. They have found that all the eight planets are traveling around the sun in the same direction, and that this direction is opposite to that of the hands of a clock. They have found that all the planets travel in paths that are nearly circular, like the hoop of a barrel. They have discovered the exact rate of travel and can tell you, at any time, in just what part of its journey each planet is, and just when the sun will shine on it in such a way that it can act as a reflector, and so shine in the heavens for us.

Now in regard to the journeys of the eight planets around the sun. I think I need not tell you that the

planets do not travel on tracks as elevated trains do, but through space just as airships travel, without anything that we can see holding them up. If the airship could let go two parallel strings as it flies, and these strings would stay in place just as the balls of twine unwind, they would represent the path through the air through which the airship flew. All of the planets travel in the same direction. All travel opposite to the direction of the hands of a clock. All travel in a circular path, yet the paths are not perfect circles but are shaped like an ellipse or flattened circle. You will remember that Mercury is nearest to the Sun, that the Earth is third in its distance from the Sun, that Neptune is farthest and that Jupiter is largest. Do not think that all these paths around the sun lie very near to it. The average distance from the earth to the sun is 92,800,000 miles, or a distance equal to 3712 trips around our world. Neptune is many, many times as far from the sun as our earth, as was explained to you from Figure 1.

Now the question comes up in your mind, "How did all these planets get to traveling around the sun in these circular paths?" You wonder why they all move in the same direction. You are surprised that they stay up in space with nothing to hold them. Well, others have wondered about these things too. Each generation has done a little toward finding out the mysteries of God's universe. What they have found they have written in books. These men have died but their discoveries have been left behind. Other men have gone on where these left off, and so each generation has grown wiser than the

last, until men have arrived at a wonderful explanation of these things.

Before I tell you their latest explanation I must tell you how very simple were men's first attempts at explaining the idea of day and night. We all know now that our world is a *spheroid*, or is shaped as a rubber ball would be if flattened a little at two points half way around the ball from each other. We know that the earth is not only traveling in a circular path around the sun, which we call *revolving around the sun*, but that, at the same time, it has another motion called *rotating on its axis*. I think the two movements of a spinning top will make these two movements clear. Sometimes the top whirls round and round in one spot so very fast we can hardly tell it is moving at all. This is *rotating*. Sometimes the top, while keeping up this rotating motion, takes a circular journey around the room. This motion we call *revolving*. The earth has these two motions. We say it *rotates* on its axis and *revolves* around the sun. We know that if a lamp were shedding light on a spinning top one side would always be in the light, the other in the shadow. Thus the spinning or rotating earth turns into the light of the sun, then the lighted part into the shadow again. In this way, we all know, we get day and night. It seems so easy to us. Men were, however, very many centuries in finding out this thing that is so simple to us. I will tell you how the early men of Egypt explained day and night, then you will see how many generations of men were needed to explain the mysteries of our world as I shall try to do for you.

The Egyptians, thousands of years ago, could see no cause for day and night but the fighting of men to make light or darkness prevail. They said the wicked god Set was determined to have it always dark. The good god Osiris was determined to have it always light. These two fought every morning and every evening. In the morning Osiris whipped his wicked brother Set. Then all was light till evening. Then another fight occurred. Set always won in the evening, then darkness he gleefully spread over all the earth. But Osiris won every morning and gladdened all the world by bringing the day. It was thousands of years after this before Magellan's ships sailed around the world and proved it to be round like a ball. This discovery is less than four hundred years old. We could not know for a certainty that the earth's rotations brought it into and away from sun light till after Magellan's ships had sailed around it and proved its spherical or ball-like shape.

Then men began to wonder why it was spherical, and why it revolved around the sun together with the other planets; why the paths of the planets all took the same direction. Three different explanations of these facts have been worked out. I shall tell you only the last and most probable of them. This is called the *Planetesimal Hypothesis* and has been worked out within the last ten years. An hypothesis is not proven beyond a shadow of a doubt, as you can prove the course of the succession of light and dark and of day and night by rotating an apple alongside the light of a lamp. It is rather a statement that we assume or declare to be true because it seems to

be true, and also because it enables us to explain some great fact. In the word *Planetesimal* you will see the word planet, which you remember means a world like ours. The Planetesimal Hypothesis then, is an explanation of how our world and the other seven planets of our solar system came to be.

I told you that this explanation is very new. The reason it is so new is because our new telescopes, that enable us to see the heavens as if they were very near, are a great improvement over the older ones. In very recent times we have also taken fine photographs of the stars, and these photographs have furnished the new explanation of how the planets came to be. Over and over again, in late years, men have taken pictures of a star and the bright haze that surrounded it. Many of these pictures look just like Figure 2. The pictures all have a bright center which, I think you will agree, looks like a sun. Around this sun is wound a lot of bright material that looks like clouds of bright colored haze. Perhaps you would say it looks like whirling masses of smoke with bright sunlight shining on

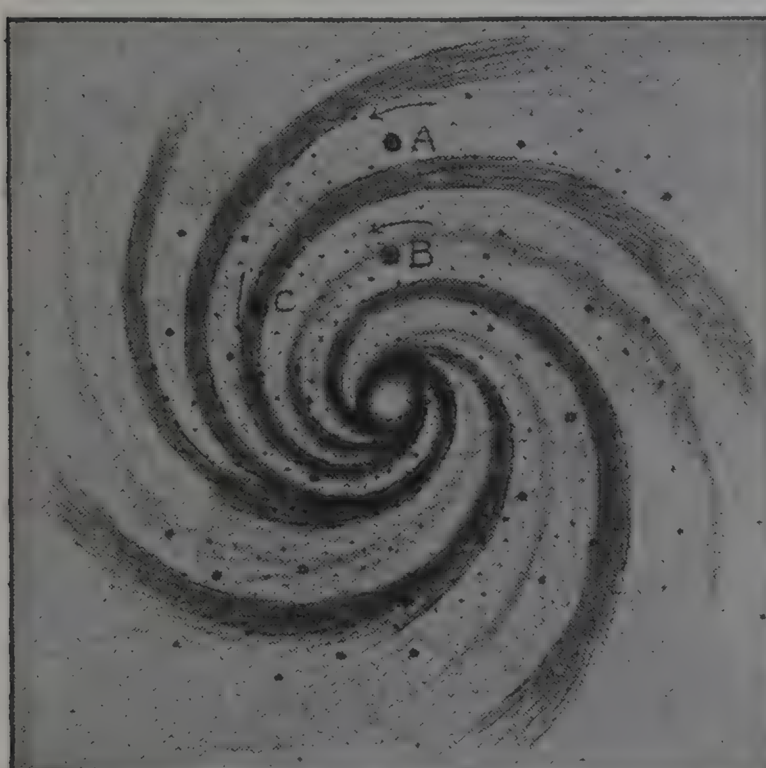


Figure 2

them and lighting them up. Now if you will look at the direction of the arrowheads in Figure 2, you will see that these lines of haze or smoke are moving around the sun in the direction our planets do. You will see also that there seem to be many solid bodies moving along in the lines or smoky parts. The great men who take these photographs have come to the conclusion that these represent a sun and planets like our own that are not yet complete, but are now only in process of making. The center, they explain, will become the sun of a new solar system like ours. The black-looking knots will become planets. The smoky matter will go to help form the planets. This smoky-looking matter, they explain, is substance like the knots, only it is in a gaseous instead of a solid form. It has not yet cooled sufficiently to become liquid or solid.

You have only to think of the three forms of water to know that the same matter may be solid, liquid or gas. We boil a tea-kettle enough and the water is all gone and in its place is only the empty kettle. That which was once water in the kettle became steam or gas and blew away in the air. So you see the same water that was liquid may become a gas. Blow your breath on a cold window pane. The moisture, which is a gas in your breath, is so chilled that it goes back to water on the window glass. Again suppose the glass to be very, very cold. The moisture of your breath will not appear on the glass as drops of liquid moisture but as frozen particles. The moisture in your breath is in the form of gas. On the first window it is in tiny liquid drops. On the

second it is in frozen or solid form. You know the water in the tea-kettle may freeze and become solid. Apply heat and it thaws or becomes liquid. Apply more heat and its form becomes gas or steam. As with water, so with all the substances that go to make the world. They may be solid, liquid or gas. You have seen lead melted and changed from solid to liquid. If enough heat were added it would become gas as water does. So would iron and gold and the many kinds of rock out of which the earth is made.

The men who make the photographs like Figure 2 believe the smoky-looking part is material rendered very hot by the heat of the central sun. As it became hot it took the form of gas, as the water of the tea-kettle does. When it cools it will become solid, as the water in the tea-kettle may freeze and become ice. The gas now seems to be a part of the central sun somewhat as our air is supposed to be a part of our world. The gas seems to be rotating about the central sun; and in the gas and going along with it, are knots of dark matter. You will notice one knot marked A, another B. You see they are both heading for the point marked C. Suppose they get there at exactly the same moment, what will happen? You say there will be a collision. If the knots are still soft, as candy might be that had been only partly cooled, the two might stick together and make only one body instead of two. That is exactly what wise men believe has happened over and over. Some of their photographs show many hundreds of these knots. They "take" white in the picture, as does the sun, and this makes us think

they may be very hot. Some of the photographs show very thick clouds of gas with many, many tiny knots of matter, and only a few larger than the rest. Others look as if the knots were fewer and larger and much of the gas cleared away.

I believe Figure 3 will make clear to you how smaller bodies may come together and blend to make one body

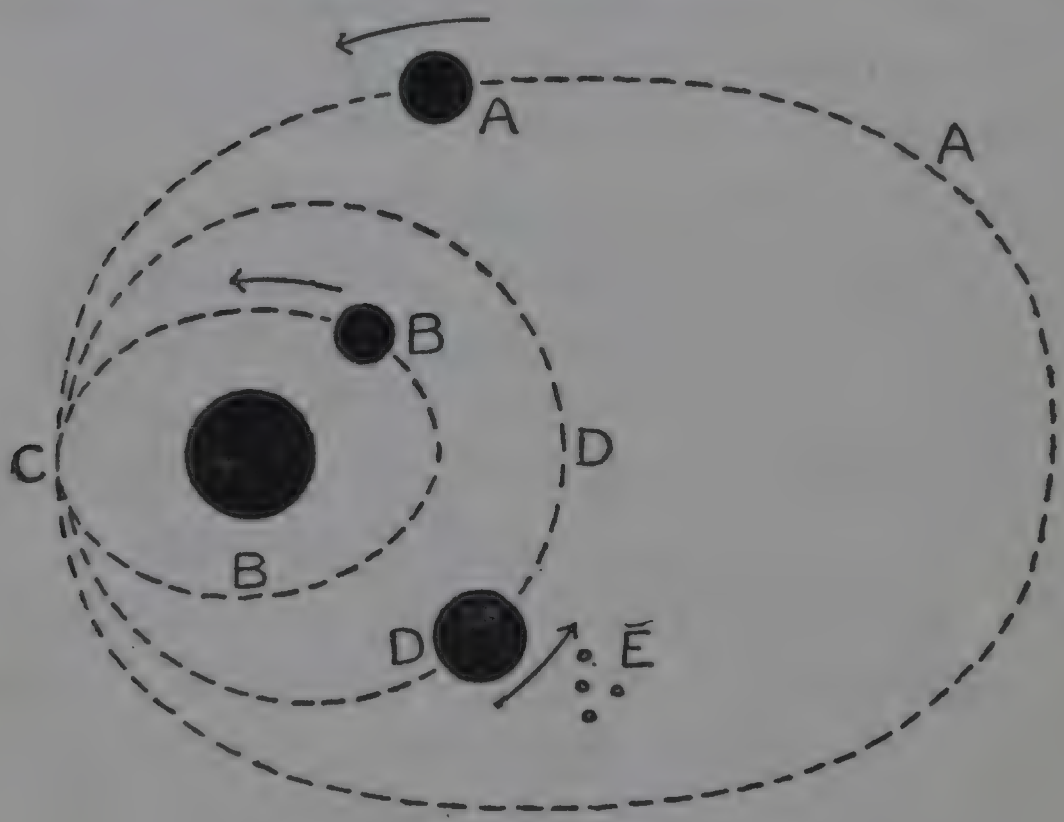


Figure 3

instead of two. Here A and B are two knots moving toward the point C. If they get there at the same moment they will have a collision. If sufficiently soft they may blend and become one body. The part that was A will want to keep on traveling on track A. The part that was B will want to keep on traveling on track B. Now since they are no longer two bodies but only one, they will have to take a middle track, as track D. This knot as it travels on track D may have collisions again and again,

and may add other matter to itself. Again, small bodies, like those marked E in Figure 3, may be drawn to the larger body and become a part of it by the law of gravitation. This law is that the bodies in the heavens are held in space by attracting or pulling on each other. The larger the body, the more power it has to pull things to it. The knot D may pull and add tiny knots to it until it gets to be very large and very powerful indeed. I think we can make this clear by what you already know about our own world.

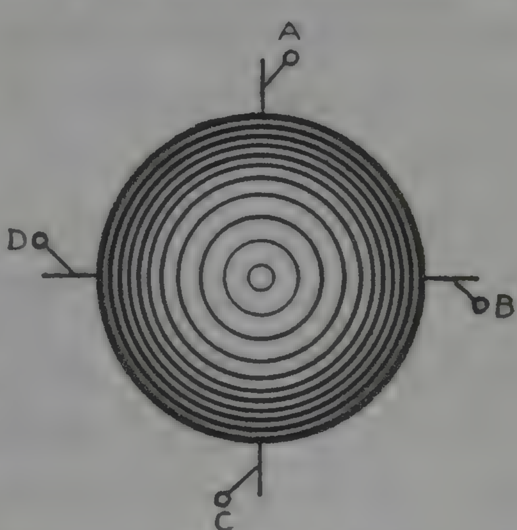


Figure 4

Let Figure 4 represent our world. Let A, B, C, and D, represent apples hanging from trees. If the one at A would drop, it is clear from its position it would light on the earth. If any of the others should drop it looks as though they might fall away from the earth. As a matter of fact, you know that every apple that falls from a tree on any part of our earth falls to the earth, no matter what the position of the tree on the earth. This law, which causes all small bodies that come near our earth's surface to fall to the earth when loosened from their hold, we call the law of gravity. Your school book slips from your hand and falls to the earth by the law of gravity. A man working on the roof of a ten-story building slips and falls to the earth by the law of gravity. Sometimes a shooting star seems to be falling toward our earth. Then it disappears and we see no more of it. This is because

it travels through our atmosphere so fast, and becomes so hot from rubbing against the air that it burns itself up before it gets to the earth.

I think the case of the apples falling to the earth and the shooting stars falling toward the earth will prove that the planets have power to add smaller bodies to themselves, in case the small body comes near enough to be pulled by the large body sufficiently hard. In the case of our solar system the sun pulls hard enough to keep the planets near it. It does not pull hard enough to make them come to it and become a part of the sun.

Let us sum up what we have said. The material like that in Figure 2 is probably all of a similar kind. Some of it still is gas because it has not cooled enough to be liquid or solid. Other parts have cooled more. Some have become liquid, some solid. As these materials whirl about the central sun part of the larger knots collide with others, and the two bodies are made one. Small knots are drawn to the large ones by the force of gravitation. The larger a body and the shorter the distance from smaller bodies, the more liable it will be to add the small body to itself. By the process of adding small bodies to larger ones many small bodies may become a few large bodies. Thus, out of many, many knots of matter, a few large bodies, like our eight planets, were probably formed. The gases cooled and made liquid or solid matter, and by the law of gravitation were gathered to the sun or to the forming planet. Finally, out of a central mass and knots of matter, developed our sun and the eight planets that travel around it.

The sun does not pull the planets hard enough to add them to itself, but hard enough to keep them near. The planets in turn pull on each other and on the sun. The force of the pull of any one of them is according to its size and the distance through which it has to pull. The shorter the distance the harder the pull. Since many of the bodies in the heavens look like Figure 2 we conclude that our solar system came from such a spiral mass of bright center and gaseous spirals filled with knots. Since some photographs show much gas and many small bodies, and others less gas and fewer but larger knots, we decide that, in process of making solar systems such as ours, the larger masses gather the smaller ones to themselves. Then, too, the matter in the spiral seems to be rotating around the central mass, as our planets rotate around the sun.

The people who have studied out this explanation call it the *Planetesimal Hypothesis*, because it tells how they think the earth and the other planets were made. This is the latest explanation and has only been thought out since the wonderful photographs like that in Figure 2 have been taken. It is hard to be perfectly sure, for the heavens are so far from us. God's work is so very wonderful and man is so tiny and ignorant. Yet as men work, from year to year and from century to century, God rewards them by letting them find out some of the mysteries of his universe. The part that is far away man learns only slowly. The part that is nearer he learns to understand much more clearly.

Now let us leave the heavens with their 100,000,000 of

suns and their planets. Let us leave even our own solar system, with its sun and eight worlds, and let us come down to our own planet, the Earth.

Look again at Figure 1 and see that it is one of the small planets and third in distance from the Sun. We know very much indeed of it, for millions of people are living on it, and men have been studying it for thousands of years. They have made many mistakes. They have also found out many truths and have handed them down to their children. Let us take up a few of the things they have learned about the earth. The moon, they have learned, is a cold body traveling in a circular path around the earth, just as the earth is a cold body traveling around the sun. Men have computed, to the minute, just how long it takes the moon to make its journey. In an almanac you will find just when the moon rises and sets each day. The sun can light but one half of the spherical moon at a time. If that lighted half is turned fully toward us we have a full moon. If but a part is turned toward us, we have but a part of a full moon. If the half that is in the dark is turned toward us we have the dark of the moon. Sometimes the earth gets between the sun and the moon in such a way as to throw a shadow on the moon. Then we say we have an eclipse of the moon. Sometimes the moon moves between us and the sun in such a way as to shut off the light coming to us from the sun or from a part of it. Then we say we have an eclipse of the sun. Is it not wonderful that men have counted so carefully that they can tell you the exact time when every eclipse will come? Look at an almanac

and find the time foretold for eclipses next year and see if they do not all come true.

If men can tell the time of the eclipse exactly, much easier have they found it to measure the earth on which they live. Let Figure 5 represent our earth. Men have found that to sail around it they must travel about 25,000 miles, or more than eight times as far as from New York to San Francisco. This they call the circumference.

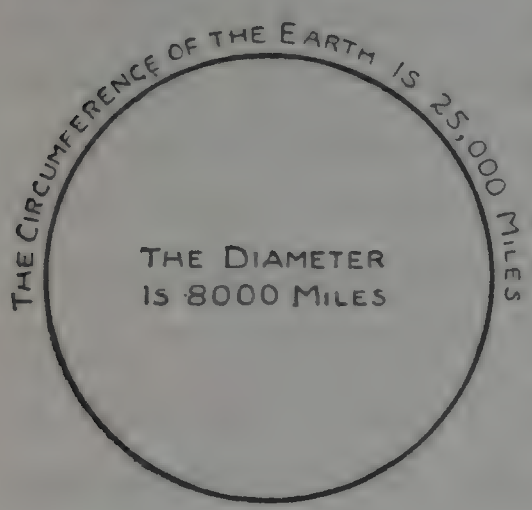


Figure 5

Men have learned that the distance through the earth, or the diameter, is 8,000 miles. These figures are not exactly right, but they are near enough for you to remember. You will wonder how they found about the diameter, for no one has been through the earth. Well, men found that in every circle the diameter and circumference bear a certain fixed ratio to each other. They found that you can measure around a plate and divide the circumference by 3.1416, or about $3\frac{1}{7}$, and find the diameter of the plate. In the same way you can get the diameter of a barrel hoop, of your watch, or of any body whose circumference is a circle. In the same way you can find the diameter of the earth by dividing 25,000 miles by 3.1416 to be about 8000 miles. In other words it is 4,000 miles from the crust to the center of the earth. When you ask how far down into the earth man has gone, I shall answer, "Not more than one four-thousandth of the way, and this only in a few spots where very deep wells are made."

Then he cannot know how the earth is made entirely to the center. Still he finds the same things used over and over again and believes that the earth and the sun and moon and planets are made up of very much the same sorts of materials. Sometimes the materials are in the state of a gas, because they have been changed by heat. Sometimes they have cooled and have become liquid. Sometimes they have cooled still farther and become solid.

It will be interesting to notice just how many different kinds of materials were used in the making of our world. When you think of the thousands of different things that you yourself have seen you are inclined to think that God must have had many thousands of different materials to use in the making of the world. You think that to make the plants and animals and men must have required thousands more different materials. If you take a large dictionary you find that it has thousands of different words. These words, however, are all made from a very few different materials. Different words are made by putting the letters together in different ways. The objects of this world are made by putting together a few materials in many, many different ways.

The characters we combine to make words we call *letters*. The materials God combined to make the world and all it contains we call *elements*. We know there are just twenty-six letters. We do not yet know just how many elements there are. Wise men have found seventy-two of these elements, but they believe there may be about eight more they have not yet found. They believe then that God made the world and all things on the world,

man included, out of eighty different materials. These materials they call elements.

Now it is not necessary for you to try to learn the names of all of these elements. A few of the most important we will learn. A good many of the less important you already know. Here is a list of the seven most important elements in the order of their importance:

1. *Oxygen*, 50 parts	5. *Magnesium*, 3½ parts
2. *Silicon*, 25 parts	6. *Sodium*, 2 parts
3. *Aluminum*, 10 parts	7. *Potassium*, 1½ parts
4 *Calcium*, 4½ parts	All the rest 3½ parts.
	Total 100

When you first look at this list of seven elements they seem to be seven strangers, but I can assure you that you have met them all. One of them you meet every hour, yes, every moment, of the day. Look at the list. Which one do you think it is? You meet more white people than Chinamen in America because there are many more whites to meet. Since half of all our world is Oxygen you certainly meet more Oxygen than any other element. I will tell you some of the places in which you meet it. One-fifth of the air you breathe is Oxygen. Eight-ninths of water, by weight, is Oxygen. When you write on the blackboard, nearly one-half the chalk in your hand is Oxygen. You pick up flint arrow-heads and they are more than half Oxygen. Don't you think this important element deserves to have its name spelled with a capital?

You will realize still more how important this fellow is when I tell you how diligently he works. You have sometimes tried to build a fire in the kitchen stove for

your mother. You were in a hurry to get out to play. You did not remove the cinders from the stove. The fire did not burn. Why? It was because the oxygen could not get to the fuel to do its work.

I told you one-fifth of our air is oxygen and that oxygen is a great worker. I told you too that all the things on this world of ours and the world itself are made up of about eighty different elements, as our words are made from twenty-six letters. The table shows you that one-half of all the world is oxygen. Since there is so much oxygen, and since it is so great a worker, we may decide that it must combine with many of the other elements in many ways and form many compounds, just as *a* and *e* and *o*, *i* and *u* combine with each other and with the consonants again and again and make thousands of words.

The wood and coal you put in the stove have a large amount of Carbon, which is another element but exists in too small quantities to get its name in with the first seven. Oxygen will combine with carbon and cause the fire to burn. The heat is caused by the union of these two elements. Now if you do not remove the cinders the air cannot get to the fuel. The oxygen of the air is not brought to the carbon of the fuel. There is no union of the two. There is no fire. If your clothing catches on fire seize a heavy blanket or coat and wrap it tightly around you. The fire will go out because the oxygen of the air is shut off. Much water thrown on a burning building does the same thing. You know how very fast a building burns if the wind is high. I think you can see why.

Oxygen unites not only with wood and coal but with many other things you know about. You have gathered up old iron to sell sometimes. Iron is another one of the eighty elements. When it combines with oxygen we have the rusting away of the iron. It, too, is burning up as it unites with oxygen. The process is slower and we call it *rusting*.

We said one-fifth of the air we breathe is oxygen. This combines with the materials of our bodies and causes them to be burned up. As they burn up they give us heat and strength. I think you will see why you become so hot when you run fast. If the fire burns well, giving us plenty of heat, it must have oxygen. If our bodies burn well, giving us plenty of heat and energy, they too must have plenty of oxygen. Do you see why the windows of our bedrooms should be left open?

Now I must tell you of some of the other combinations of oxygen. You see in this that Silicon is second. One-half of the world is oxygen, one-quarter of the world is silicon. I think we may infer that they often combine. So they do. One part of silicon and three of oxygen combined and you have *Silica* or *Quartz*. It is said that, in different forms, silica makes up one-third of the earth's crust. You have seen much of it. Go to a marble yard and notice the granite tombstones. You will know granite because it is made up of different colored grains all cemented together. The bright, shiny, glossy looking grains are silica, or quartz. As granite wears away, this bright, shiny quartz becomes sand. Look at a handful of sand. The shiny particles you see are finely-

weathered quartz. The flint arrow-heads you have handled are quartz also. The glass from which you drink at the table and the glass of your windows are largely quartz. You can hardly think of two things less alike than granite and window glass, yet quartz makes up much of each. Quartz is very hard indeed and when accidentally mixed with a little coloring matter, by nature, it makes up some of our finest stones. The amethysts, agates and opals that you can see in any jewelry store are quartz and a bit of coloring matter. Quartz is silica, and Silica is oxygen and silicon combined.

Now take the third in order of our seven most important elements, Aluminum. You are familiar with this for your mother has aluminum kettles. If not, you can see them in any hardware store. You have perhaps tasted alum. This gets its name from aluminum. Aluminum combines with oxygen to make alumina.

Potassium, the last in the list of our important elements, combines with oxygen to form potassa. Alumina and potassa combine to form alum. You have seen aluminum in at least two other forms. The emery wheel used for grinding and the emery in a tiny bag used by your mother to brighten her needles are alumina mixed with a little impurity. Again the glittering, bright blue stone used in finger rings and called sapphire is alumina. You see that you are already familiar with some of the elements and with some of their compounds.

You are very familiar with the next compound of which I shall tell you. The fourth in our list of elements is Calcium. Combine this with oxygen and you have lime.

Your mother has scattered lime about the chicken house to kill insects that might injure the chickens. You have seen lime used, too, to make plaster for the house. Now lime is combined with carbonic acid. This gas you throw off from your lungs with every breath, and you ought to know what it is. Its symbol is CO_2. That means it is one part carbon and two oxygen. Carbonic acid combines with lime and we have carbonate of lime. Now have you ever seen carbonate of lime? Yes, more times than you have fingers and toes. Most of the stone buildings of your city are carbonate of lime, or more commonly called limestone. Many of the stones you pick up in the street are limestone. You can test for limestone by pouring hydrochloric acid on stones. If they are limestone they will effervesce or send off bubbles. The acid is combining with the lime. Southeast England is made up largely of chalk cliffs. Ninety-six parts of every hundred of this chalk is carbonate of lime. Test your chalk at school with hydrochloric acid and see if it will effervesce. Many of the corals are carbonate of lime. Try a piece of coral with acid and see the result. The bones of animals and of man are carbonate of lime. Test some chicken and fish bones by treating them with acid. Make a solution with about half acid and half water and let the bones stand in it. You may live in a region where you can find great layers of stone as they exist in the earth. Such layers may be seen on the sides of mountains, on the faces of sea cliffs, in a railroad cut or in a stone quarry. Many of these are limestone. Test them with acid. Marble, such as is used in the bath-

room and for tombstones, is also carbonate of lime. The very pleasing coloring is due to impurities. Test some marble for carbonate of lime.

As I said at first, we cannot learn the names of the seventy-two elements man has found. We can only learn a little about the commoner ones. There is, however, one more of our seven which you eat every day and ought to know., That is Sodium, the sixth in our list of seven elements. This when combined with another element gives us common salt. Another of the elements you drink in large quantities. Water is two parts of hydrogen to one part of oxygen. The symbol for it is H_2O. When we were children and wished to appear wise we said, "Pass the H_2O." You would know what was meant, I am sure. Hydrogen is not common enough to be one of the seven most important elements of our list. Still, it is very important, for it forms about two-thirds of water, by volume.

Potassium, as we have stated in an earlier paragraph, unites with oxygen to form potassa. This you know, perhaps, as potash or lye that is used to make hard water soft to bleach or remove dirt from cloth. It is used, too, to make soap. When I was a child we used to put wood ashes in a wooden vat or barrel. Water was poured over the top, and soaking down through the ashes, ran out of holes at the bottom. This liquid we called lye. It was potash and my mother used it to make soap.

There are still others of our seventy-two known elements that are quite familiar to you, though you do not yet know them as elements. I suspect you call them

metals. They are elements, but have certain properties that give them the common name metals. All are solid at ordinary heat. All of them have a peculiar luster. All of them are good conductors of heat and electricity. By that I mean that heat and electricity will travel over a bar or wire made of a metal, without much loss. All of the metals are elements that exist in but small quantities and are found by digging into the earth. All the metals existed at first in very small, scattered particles. Running water, especially when hot, has gathered these little particles from the rock over which the water ran. The water would find cracks in the rock and deposit its load of metal in the crack. Thus are built up veins of gold, silver, lead, copper and other metals. The gold of California, you may know, was found in the sands in the beds of rivers. It was once scattered through much soil and rock that filled up what is now the river bed. The soil and rock were worn away by the running water. The gold was heavier than the soil and too heavy to be washed away. It, therefore, sank down and remained in the sand in the river bed. Gold, you know, is very valuable. The reason is that it is not subject to oxidation. You ought to know what that means, but for fear you do not I will tell you. You will remember that we said the oxygen that makes one-half of the world is a very active agent. It will combine with almost anything. When it combines the thing passes away. When it combines with the Carbon of our coal the coal burns up. When it combines with iron the iron rusts away. We say oxidation takes place. Oxygen, active as it is, has no power over gold,

so gold does not rust or oxidize but remains always bright and beautiful.

Gold is our most valuable metal, but by no means the one we need the most. Iron is the one without which our modern civilization could not exist. We combine iron with a little carbon, such as exists in our wood and coal, and we have steel. Steel, as you know furnishes us many of our useful things. The rails of our railroads are steel. The engines and cars are mostly steel. The ships that cross the seas are now entirely of steel. The frames of our great buildings are also of this metal. Our saws and planes, hammers, knives and hinges are all of steel. Our guns and swords are steel. It is not hard to see that of the elements called metals iron is the most important.

You are very familiar with many others of the metal elements, such as silver, from which your money and teaspoons were made. You are familiar with copper, that is used for kettles, for wash-boilers and for wire. You have all seen lead pipes used to carry water. I am sure you have all drunk from tin cups. Zinc you may have used under your stoves to protect the floor from the heat or your mother may have had the kitchen table covered with it. Platinum you may have seen in wire. It makes better wire than steel, as oxygen has no effect on it and therefore it does not rust. Platinum is the heaviest of all the metals. Mercury you have seen in your thermometer. This metal does not change from the liquid to the solid form until it reaches—40°F., therefore we use it for thermometers, excepting in far northern countries

where it would freeze. It expands with the application of heat very rapidly, and contracts when cooled. Thus the rising and falling mercury tell us of all our changes in heat.

You will see in our little table that eighth and last we have 3½ parts which we called "all the rest." The metals that we have named, the carbon, the hydrogen, and in fact, all of the seventy-two known elements, but the seven we named in the list, belong in this tiny amount, 3½ parts of the world.

In this little book you have learned something of the meaning of the starry sky. You found that our own solar system is made up of a central sun and eight planets that revolve around it. The Planetesimal Hypothesis told you how wise men of today think our solar system was made. In connection with our own world you learned its size and shape, its movements, the cause of day and night, the causes of the different phases of the moon. You have learned, too, a score or more of the elements used to build this earth of ours. Some of the most common of the combinations of these elements you have learned as well. Now if you will read "The Builders of the World and How They Do Their Work," you will find out more of how this world was made.

A *mineral* is a definite compound made by uniting elements. This idea of minerals must be kept clear and not confused with *metals* which you will remember are elements.

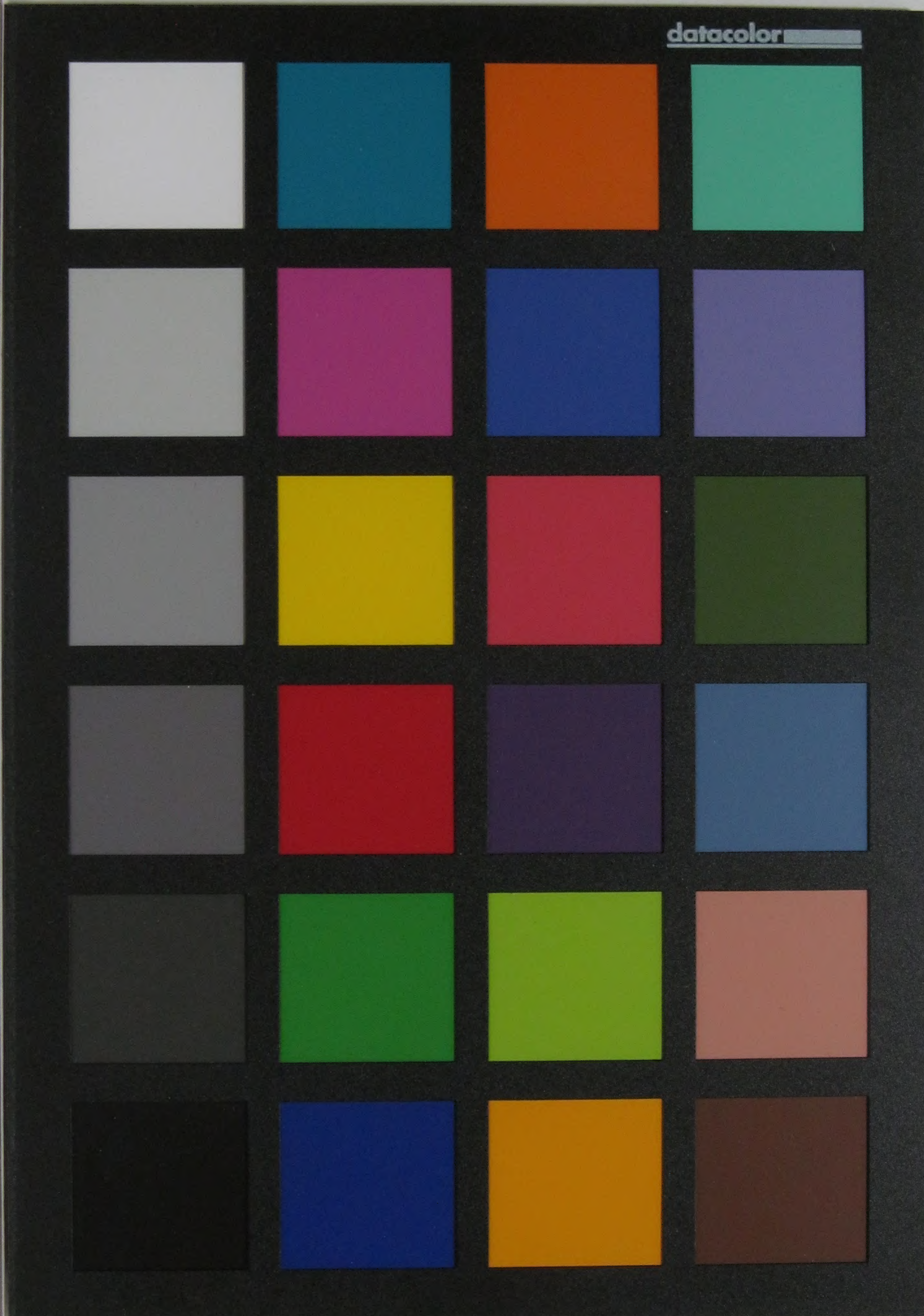
Write a paper on the *Planetsimal Hypothesis*.

Write what you know of our *Solar System*.

Name all the *elements* you know that have entered into the making of our world.

What are the following and of what were they made; *chalk, agate, quartz, water, iron, rust, lime, carbonic acid, marble, coal, steel, opal, sapphire, emery, salt and potash?*

"The Builders of the World," by the same author, is No. 281 of The Instructor Literature Series.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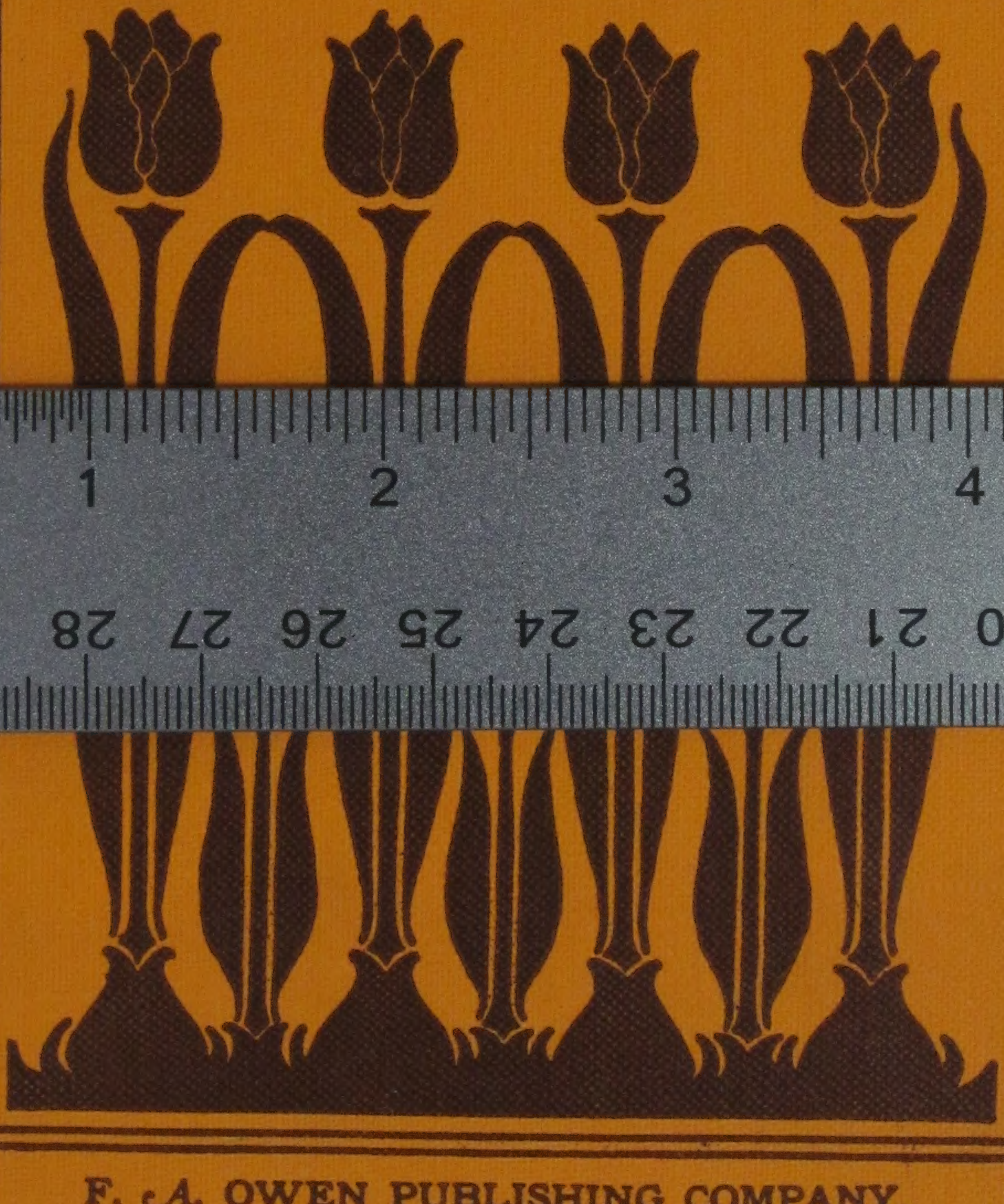
The Making of the World

BY CARRIE P. HERNDON



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